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Testing the functional accuracy of total-station laser plummets using remote sensing methods

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INTRODUCTION

Summary: The accuracy assessment of the laser plummets of surveying instruments is an essential element in testing their efficiency. Existing procedures use known methods like the projection on the reference plane, using auxiliary lines drawn with threads, or other empirical, mostly field methods. Such tests are usually carried out for standard - short distances limited to standard heights of instruments set up on tripods. In works related to quantity surveying in civil engineering, however, it is increasingly necessary to use longer centre line-of-sights. It is mostly associated with the need for transferring coordinates of a reference frame to the next floors. Additionally, the accuracies of projecting plumb lines currently offered by the manufacturers of high-precision electronic total stations make it possible to carry out very advanced works as ex. Structural monitoring. Therefore, it is desirable to work on reliable methods for testing the efficiency of such devices. What is more, it is crucial to provide reliable validation of their operational accuracy. Such requirements have become the motivation of the authors to undertake the research on developing new remote sensing methods for precise assessment of the instrument centring accuracy. For this purpose, they used an autocollimation mirror and employed methods of image recording.

Keywords: precise total stations, laser plummet, autocollimation mirror, measuring adapter, image analyse.

SELECTED TEST RESULTS

Figure 1 View of the tested instruments set up on classical tripod stands

Such a two-step procedure allows for the validation of the actual operational accuracy of the instrument's laser plummet. Additionally, to test the performance of the plumbline projection at different distances, a laser beam was emitted towards the autocollimation mirror (Fig. 3), which directed it to the reading target plates placed at different lengths (Fig. 4).

Figure 3 View of an autocollimation mirror

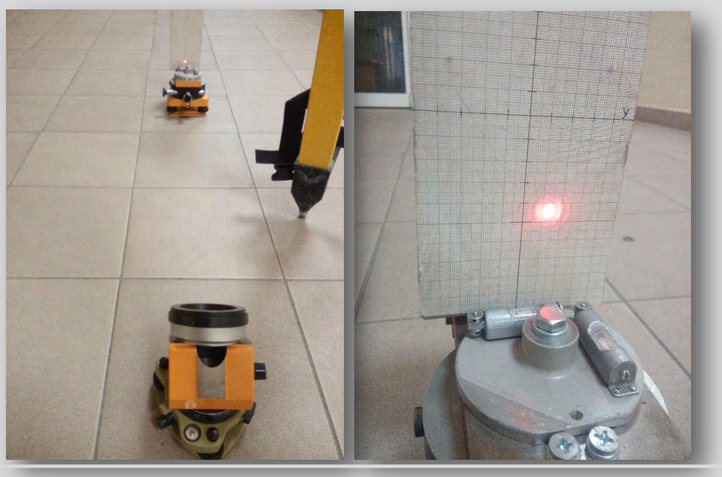


Figure 4 View of the test stand using an autocollimation mirror

Our solution employing an autocollimation mirror allowed for testing the accuracy of plummets for different standard distances: 2m, 5m, 10m, 15m and 20m. Such an approach reflects the situation encountered on construction sites when transferring the reference frame vertically and assessing the verticality of the structure.

The laser spot is pictured and analyzed by using especially dedicated software (utilizing picture recognition algorithm). Based on that, we can estimate both the spot's size as well as its tracing.

In the tasks of geodetic deformation monitoring, the principal instruments that constitute the core of such systems are precise electronic total stations (Fig. 1). Checking the accuracy of their operation (so-called 'validation') is a necessary step to keep the entire system operational. It is directly tied with the final accuracy of determined displacements.

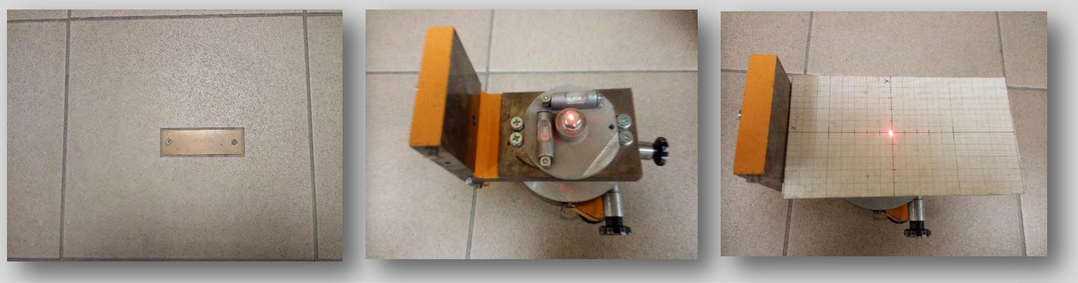
Proposed testing approach

The stability of the measuring stand is, therefore, crucial. In this context, the correct implementation of the instrument's plumb line is particularly important. It is particularly important in construction and assembly works, e.g. while transferring the reference frame to subsequent building floors. Hence, testing the accuracy and providing functional control of laser plummets integrated with total stations should be carried out according to reliable procedures. Regarding that, the authors proposed two coherent approaches:

1. with instruments placed on a tripod,
2. with instruments placed on a special , own developed adapter (Fig. 2).

The developed measuring adapter allows for independent testing of the laser plummet by turning the entire tribrach properly. The device is placed on a tripod and attached to it with a heart screw. Then, using special clamps, the instrument is accordingly suspended. The emitted laser beam is projected either directly to the reading target plate or to the surface of an autocollimation mirror, which forwards it to the relevant targets.nif.

Figure 2 View of the test stands utilizong the developed measuring adapter



CONCLUSIONS

Tests of various total station models have demonstrated the effectiveness of the proposed solution. It significantly increases the reliability of the examination and allows for assessing the functionality of laser plummets on different distances, which often occurs during construction surveys. Moreover, reliable checking of the instrument's ability to restore a plumb line directly transfers into the accuracy of 3D positioning, which is particularly applicable in geodetic deformation monitoring.

All pictures by Krzysztof Karsznia

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